MYCOTAXON

ISSN (print) 0093-4666 (online) 2154-8889 Mycotaxon, Ltd. ©2017

July–September 2017—Volume 132, pp. 539–546

https://doi.org/10.5248/132.539

Lecanora subloekoesii sp. nov. and four other species of the *L. subfusca* group new to China

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Abstract—A new species of *Lecanora* is described from China: *L. subloekoesii*, which is similar to *L. loekoesii* but differs by its 8-spored asci. Four species newly recorded from China are discussed: *L. chionocarpa*, *L. hybocarpa*, *L. praepostera*, and *L sulcata*. A detailed taxonomic description, ecological and chemical characters, and illustrations are provided for the new taxon, and brief comments and illustrations for the newly reported taxa.

Keywords—1-septate ascospore, *Ascomycota*, *Lecanorales*, *Lecanoraceae,* usnic acid

Introduction

Lecanora Ach., a cosmopolitan genus with over 552 species (Kirk et al. 2008), is one of the largest genera of lichenized ascomycetes. It is a heterogeneous assemblage of different groups, several of which probably deserve generic rank (Lumbsch & Elix 2004, Zhao et al. 2015). The *Lecanora subfusca* group, which is the core group that includes the type species, is characterized by the presence of oxalate crystals in the amphithecium and the production of atranorin and/or usnic acid in the cortex (LaGreca & Lumbsch 2001). The group has received considerable attention during the past few decades, which has resulted in numerous regional revisions and the description of numerous new species (Brodo 1984; Miyawaki 1988; Brodo et al. 1994; Guderley 1999; Guderley & Lumbsch 1999; Lumbsch & Elix 2004; Ryan et al. 2004; Nayaka 2005; Han et al. 2009; Knudsen & Lendemer 2009; Lü et al. 2011).

During study of *Lecanora* in China, an unreported species belonging to the *L. subfusca* group was discovered to represent a new species, proposed here as *Lecanora subloekoesii.* In addition, four other species belonging to this group, *L. chionocarpa*, *L. hybocarpa*, *L. praepostera*, and *L. sulcata*, are reported here as new records from China.

Materials & methods

The specimens studied are housed in the Lichen Section of the Botanical Herbarium, Shandong Normal University, Jinan, China (SDNU) and at the Korean Lichen Research Institute, Sunchon, Korea (KoLRI).

The specimens were examined morphologically under a COIC XTL 7045B2 stereomicroscope and photographed using an Olympus SZX16 dissecting microscope. The anatomical characters, such as apothecial tissues, crystal types, asci, ascospores and so on, were examined by hand-cut sections under an Olympus CX41 polarizing microscope and photographed using an Olympus BX61 with DP72. Lichen substances were identified using spot tests and standardized thin layer chromatography techniques (TLC) with solvent system C (Orange et al. 2010).

Taxonomy

Lecanora subloekoesii Z.T. Zhao & L. Lü, **sp. nov.** Pl. 1

MycoBank MB 812188

Differs from *Lecanora loekoesii* by its brown to reddish brown apothecial discs and its 8-spored asci.

Type: China. Heilongjiang Province, Wuchang, Mt. Datudingzi, 44°31′N 128°15′E, alt. 1200 m, on bark, 21/VIII/2011, Y.L. Cheng 20122275A (**Holotype,** SDNU).

Etymology: The epithet refers to the similar species, *L. loekoesii.*

Thallus crustose; surface dirty gray to yellowish gray, continuous to rimose-areolate, rough to verruculose, esorediate; margin indistinct; prothallus not visible. Apothecia lecanorine, sessile, 0.3–1.7 mm in diam; disc brown to reddish brown, epruinose, plane to convex; margin paler than thallus, thin to thick, prominent, entire to flexuous, smooth. Amphithecium with small crystals insoluble in K, 100–135 μm thick; cortex indistinct, basally not thickened, cortical granules dissolved in K; parathecium hyaline, with crystals soluble in K; epihymenium brown to reddish brown, pigment soluble in K, with coarse crystals soluble in K, 10–12.5 μm thick; hymenium hyaline, 55–60 μm thick; subhymenium hyaline to pale yellow, 25–35 μm thick; hypothecium indistinct; paraphyses simple, expanded in the tips, up to 1.5 μm wide; asci clavate, 8-spored; ascospores hyaline, simple (or appearing 1-septate due to divided protoplasm), ellipsoid, 10–15 × 4–7μm, wall <1 μm thick. Pycnidia not observed.

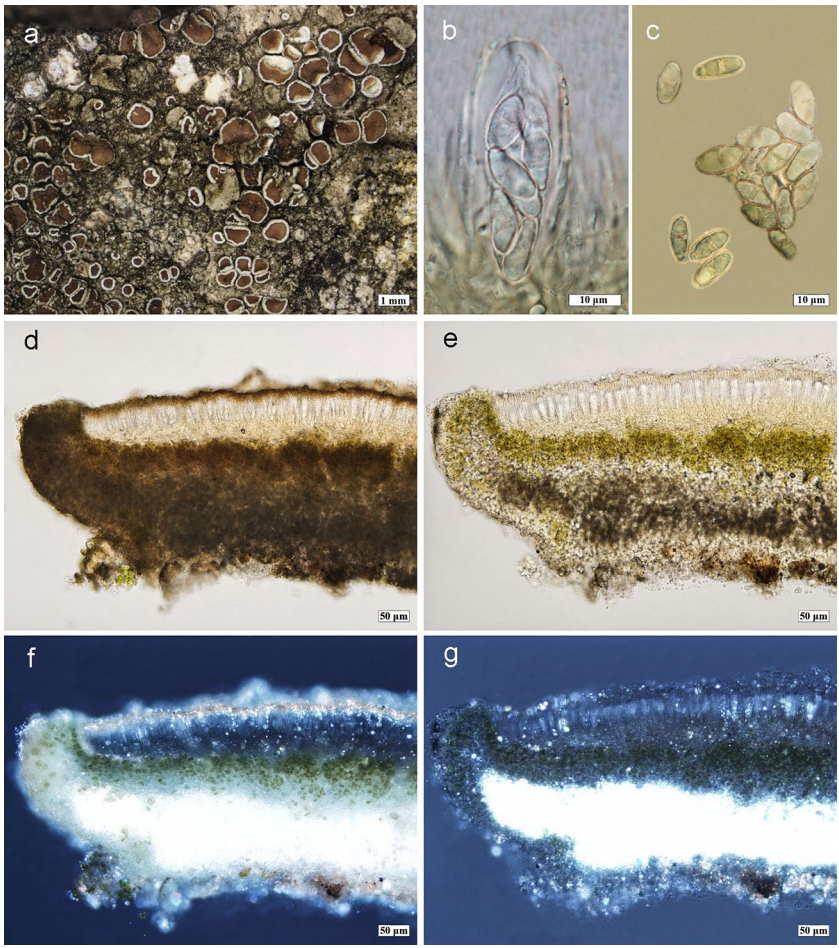

Plate 1. *Lecanora subloekoesii* (holotype, SDNU). a: Thallus. b: Ascus. c: Ascospores. d: Apothecium section. e: Pigment of epihymenium soluble in K. f: Crystals in apothecium section. g: Crystals of epihymenium soluble in K. Scale bars: a = 1 mm; b, c = 10 µm; d–g = 50 µm.

Chemistry: cortex: K+ yellow, C–, KC+ yellow, P–; medulla: K+ yellow, C+ yellow, KC+ yellow, P–; atranorin, usnic acid, zeorin, and traces of norstictic acid present.

Ecology and distribution: The new species was found on bark from mountainous regions of Anhui, Heilongjiang, Jilin, Liaoning, and Shanxi Provinces, at elevations of 900–2000 m.

Additional specimens Examined (all in SDNU, unless otherwise indicated):

Lecanora subloekoesii **CHINA. Anhui Province**, Liuan, Huoshan, Mt. Baimajian, alt. 1200 m, on bark, 8/ VI /2011, Y.L. Cheng 20113302A-1. **Jilin Province**, Wangqing, Dadoudiwa, alt. 900 m, on bark, 23/VII/2012, H.Y. Wang 20128212, 20128215, 20128216, 20128209; Mt. Tulaopodingzi, alt. 1100 m, 22/VII/2012, H.Y. Wang 20128201, 20128220, 20128223; Mt. Naitou, alt. 1100 m, 18/VIII/2011, Y.L. Cheng 20120112B. **Liaoning Province**, Kuandian, Mt. Huabo, alt. 800 m, on bark, 18/VIII/2011, D.F. Jiang 20120395D. **Shanxi Province**, Ningshan, Pingheliang, alt. 2060 m, on bark, 28/VII/2005, Y.J. Li & W. Fu L-928B.

Lecanora allophana (Ach.) Nyl.: **CHINA**. **Gansu Province,** Wenxian, Qiujiaba, alt. 2350 m, 3/VIII/2006, X.L. Shi 061572-2; alt. 2610 m, 4/VIII/2006, C.L. Wang 062133; Zhouqu, Huacaopo, alt. 3200 m, 29/VII/2006, Z.T. Zhao 060893. **Shaanxi Province**, Meixian, Mt. Taibaishan, alt. 1610 m, 1/VIII/2005, X.L. Shi QL582; alt. 1800 m, 2/VIII/2005, S.X. Guo QL275.

Lecanora imshaugii Brodo **CHINA**. **Anhui Province,** Liuan, Huoshan, Mt. Baimajian, alt. 1100 m, 9/VI/2011, Y.L. Cheng 20113257A; Y. Dong 20112999A; alt. 1400 m, 8/VI/2011, H.Y. Wang 20113364B. **Gansu Province,** Wenxian, Qiujiaba, alt. 2690 m, 4/VIII/2006, Z.F. Jia 062225.

Lecanora loekoesii L. Lü et al.: **CHINA. Heilongjiang Province**, Wuchang, Mt. Datudingzi, alt. 1800 m, 21/VIII/2011, Y.L. Cheng 20122274B; alt. 1300 m, 21/VIII/2011, Y.L. Cheng 20122316B. **SOUTH KOREA**. **Gangwon-do**, Taebaek-si, Mungoksodo-dong, Mt. Taebaek, 37°06′49″N 128°56′51″E, alt. 910 m, on *Quercus* bark, 13/X/2005, Lőkös 050717 (holotype, KoLRI).

Remarks: The new species is characterized by the amphithecium with small crystals, an epihymenium with coarse superficial granules, and the presence of usnic acid, zeorin, and norstictic acid besides atranorin. Another *Lecanora* with 1-septate ascospores is *L. loekoesii,* which has the same chemistry but differs in the yellowish brown apothecial discs and 12–16-spored asci. Both *L. subloekoesii* and *L. loekoesii* are distributed in mainly Northeast China, but they are allopatric and *L. loekoesii* has a wider elevation range (488–2900 m). *Lecanora subloekoesii* is morphologically similar to *L. allophana* and *L. imshaugii*, but both of them lack granules or crystals in the epihymenium. Moreover *L. allophana* contains only atranorin alone, while *L. imshaugii* contains atranorin and zeorin.

Lecanora chionocarpa Hue, Ann. Mycol. 5: 89. 1907. Pl. 2A

Chemistry: atranorin, zeorin; other unidentified substances also sometimes present.

Distribution: *L. chionocarpa* has been reported from Japan and Korea (Miyawaki 1988). New to China.

Specimens examined (all in SDNU):

Lecanora chionocarpa: **CHINA. Heilongjiang Province**, Tielishi, Taoshan national forest park, alt. 800 m, 23/VIII/2011, Y.L. Cheng 20125506, 20125333;

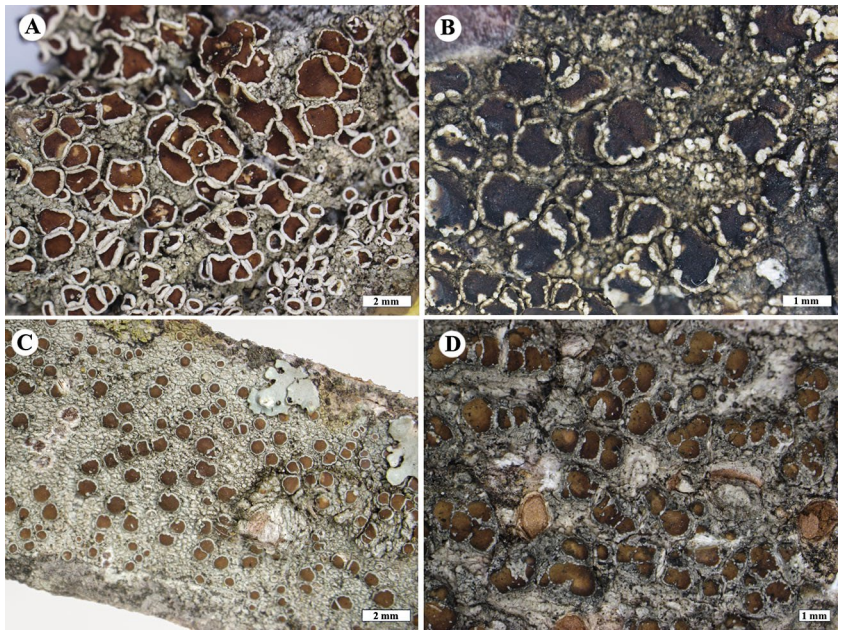

Plate 2. *Lecanora* species, new records in China.
A. *L. chionocarpa*. B. *L. hybocarpa*. C. *L. praepostera*. D. *L. sulcata*

Wuchang, Mt. Datudingzi, alt. 800 m, 21/VIII/2011, Y.L. Cheng 20122221, 20122247A, 20122247B; Tahe, Mengkeshanlinchang to Walaganzhen, alt. 555 m, 14/VIII/2009, Z.J. Ren 20102035. **Henan Province**, Nanyang, Neixiang, Mt. Baotianman, alt. 1600 m, 14/VI/2011, H.Y. Wang 20113298; Y. Dong 20113837; alt. 1700 m, 14/VI/2011, H.Y. Wang 20113669; Luanchuan, Mt. Laojun, alt. 1800 m, 12/VI/2011, H.Y. Wang 20113378. **Jilin Province**, Fushun, Mt. Changbai, alt. 640 m, 1989, Z.T. Zhao 9802402A, 9802402B, 9802402C; Wangqing, Dadoudigou, alt. 900 m, 23/VII/2012, H.Y. Wang 20128245, 20128258, 20128233; Changbaishanlvyouqu, Chibeiqu, Mt. Naitou, alt. 1100 m, 18/VIII/2011, Y.L. Cheng 20120060A, 20120100B, 20120100C; Helong, Mt. Zengfeng, alt. 1600 m, 19/VIII/2011, D.F. Jiang 20119398, 20119530. **Liaoning Province**, Kuandian, Mt. Huaboshan, alt. 900 m, 16/VIII/2011, Y.L. Cheng 20120458A, 20120553; alt. 950 m, 16/VIII/2011, D.F. Jiang 20120562. **Shandong Province**, Yantai, Mt. Kunyu, alt. 400 m, 17/XI/2010, Z.J. Ren 20127922.

Lecanora megalocheila (Hue) H. Miyaw.: **CHINA**. **Anhui Province,** Liuan, Huoshan, Mt. Baimajian, alt. 1100 m, 9/VI/2011, Z.L. Huang 20112944A; Y. Dong 20113221. **Heilongjiang Province,** Tielishi, Taoshan national forest park, alt. 800 m, 23/VIII/2011, Y.L. Cheng 20125691; Wuchang, Mt. Datudingzi, alt. 1100 m, 21/VIII/2011, Y.L. Cheng 20122379.

Remarks: The species is characterized by the cottony appearance of its thallus, white fibrous prothallus, non-granular epihymenium, and abundant

production of zeorin. *Lecanora allophana* and *L. megalocheila* are similar to *L. chionocarpa*, but *L. allophana* contains atranorin alone, and *L. megalocheila* has a granular epihymenium.

Lecanora hybocarpa (Tuck.) Brodo, Beih. Nova Hedwigia 79: 134. 1984. Pl. 2B

Chemistry: atranorin alone.

Distribution: *L. hybocarpa* has been reported from eastern North America (less common in the west) and western Europe (Ryan et al. 2004). New to China.

Specimens examined (all in SDNU):

Lecanora hybocarpa: **CHINA. Gansu Province**, Zhouqu, Shatanlinchang, Renmingdigou, alt. 3100 m, 30/VII/2006, H.Y. Wang 061334. **Yunnan Province**, Luquanxian, Jiaozixueshan, alt. 3600 m, 4/XI/2012, H.Y. Wang 20129377.

Lecanora chlarotera Nyl.: **CHINA. Fujian Province,** Wuyishanshi, Tongmusangang, alt. 1200 m, 24/X/2010, D.F. Jiang 20105660A, 20105660B. **Guizhou Province**, Libo, Maolanbaohuqu, alt. 350 m, 2/XI/2009, H.Y. Wang 20102328, 20102339.

Lecanora pulicaris (Pers.) Ach.: **CHINA**. **Sichuan Province**, Litangxian, Mt. Kazila, alt. 4700 m, 7/XI/2008, Z.S. Sun 20080650; alt. 4700 m, 7/XI/2008, Y.D. Du 20080281. **Xizang Province**, Linzhidiqu, Lulangzhen, Mt. Sejila, alt. 4200 m, 27/XI/2007, G.Y. Han 20073298. **Yunnan Province**, Lijiangshi, Mt. Laojun, alt. 3800 m, 5/XI/2009, H.Y. Wang 20100257.

Remarks: The species is characterized by pale to dark orange-brown apothecial discs, verruculose to verrucose apothecial margin, the epihymenium with fine granules, and a relatively uniformly thickened apothecial cortex. *Lecanora hybocarpa* is similar to *L. chlarotera* and *L. pulicaris*, but *L. chlarotera* contains gangaleoidin and has a coarsely granular epihymenium, and *L. pulicaris* usually contains fumarprotocetraric acid besides atranorin and has an expanded cortex at the apothecial base.

Lecanora praepostera Nyl., Flora 56: 19. 1873. Pl. 2C

Chemistry: atranorin and norstictic acid present.

Distribution: *Lecanora praepostera* has been reported from the U.K., France, Canary Islands. (Hawksworth & Dalby 1992). New to China.

Specimens examined (all in SDNU):

Lecanora praepostera: **CHINA. Jilin Province**, Changbaishanlvyouqu, Chibeiqu, Mt. Naitou, alt. 1100 m, 18/VIII/2011, Y.L. Cheng 20120121B, 20120121C, 20119624; Helong, Mt. Zengfeng, alt. 1500 m, 19/VIII/2011, Y.L. Cheng 20119687, 20119807, 20119759. **Shaanxi Province**, Ningshan, Baiyangling, alt. 2075 m, 30/VII/2005, W. Fu 20127925.

Remarks: The species is characterized by the cracked-areolate thallus, an epihymenium with K+ red, coarse granules, and the presence of norstictic acid beside atranorin. *Lecanora praepostera* can be distinguished from most

other species of *Lecanora* in China by the K+ yellow to red thallus cortex and amphithecium producing small K+ red acicular crystals.

Lecanora sulcata (Hue) H. Miyaw., J. Hattori Bot. Lab. 64: 307. 1988. Pl. 2D

Chemistry: atranorin present.

Distribution: *L. sulcata* has been reported from Japan and Korea (Lü et al. 2011). New to China.

Specimens examined (all in SDNU):

Lecanora sulcata: **CHINA. Guizhou Province,** Kaili, Mt. Leigongshan, alt. 1800 m, 24/VIII/2010, D.F. Jiang 20103273A. **Shaanxi Province**, Ningshan, Pingheliang, alt. 2550 m, 3/VIII/2005, C.L. Wang TBW196.

Lecanora cinereofusca H. Magn.: **CHINA. Fujian Province,** Wuyishanshi, Tongmucun, Guidun, alt. 1200 m, 26/X/2010, D.F. Jiang 20105040; X.R. Kou 20105145. **Guizhou Province,** Kaili, Leigong, Mt. Leigong, alt. 1800 m, 24/VIII/2010, D.F. Jiang 20112149. **Jilin Province**, Helong, Mt. Zengfeng, alt. 1600 m, 19/VIII/2011, Y.L. Cheng 20119892.

Lecanora insignis Degel.: **CHINA. Fujian Province,** Wuyishanshi, Tongmusangang, alt. 1200 m, 25/X/2010, H.Y. Wang 20105471B, 20105092B, 20105091A. **Gansu Province,** Wudu, Pandixiang, Tielugou, alt. 1650 m, 07/VIII/2006, F. Yang 062497-1, 062497-2; Zhouqu, Renmingdigou, alt. 2780 m, 30/VII/ 2006, L. Lv 061274; Diebu, Yiwagou, alt. 3600 m, 25/VII/ 2006, Z.T. Zhao 060024; alt. 3680 m, 25/VII/ 2006, X.L. Shi. 060070-2.

Remarks: The species is characterized by verrucose to sulcate apothecial disc margins (not evident in the young apothecia shown in Plate 2D), coarsely granular epihymenium, large crystals in the amphithecium, and the presence of atranorin alone. *Lecanora sulcata* is similar to *L. cinereofusca* and *L. insignis* in having discontinuous apothecial margin but can be distinguished from both species by the lack of pannarin.

Acknowledgements

The study was financially supported by the National Natural Science Foundation of China (31300018). The authors are grateful to I.M. Brodo and Ze-Feng Jia for reading and improving the manuscript, and for acting as presubmission reviewers. The first author thanks SDNU for providing laboratory facilities to work.

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